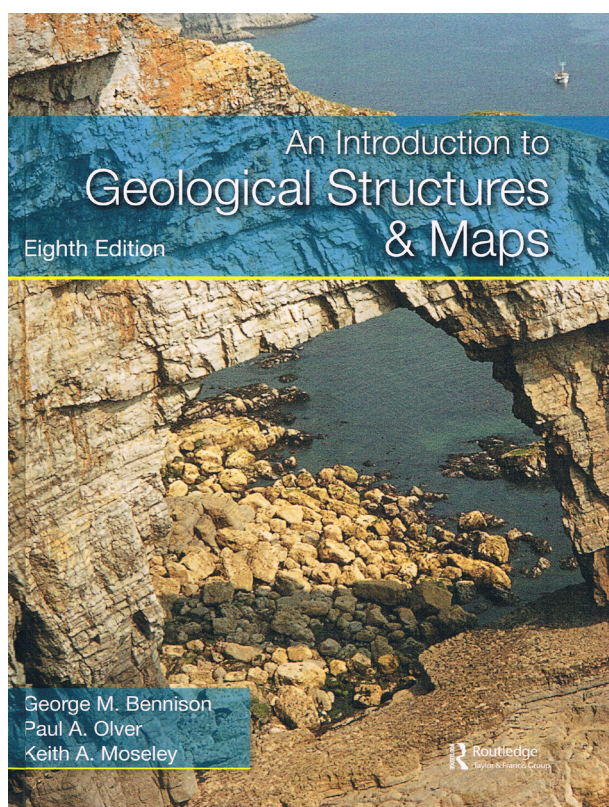


An introduction to geological structures & maps, by G.M. Bennison, P.A. Olver & K.A. Moseley, 2017. Routledge, New York/London, 184 pages. Hardback: price GBP 120.00, ISBN 978-1-03232015-1.



In my opinion, one of the best measures of book quality and impact is the number of its editions. The present review involves the eighth edition of the textbook by George M. Bennison and co-authors, which indirectly confirms its high level and great popularity among teachers and students over several generations. This tome was first published in 1964! Both the content and design clearly explain its success. The book is focused on the traditional attitude to geological maps. It refers to the use of pen and paper (ruler and protractor, as well), rather than working with a computer or other digital instruments. However, this is absolutely not a drawback of this textbook, because it develops in the readers, most possibly an Earth science beginners, geological thinking and introduces him/her to the geometrical issues that stand behind any visualis-

ation of geological structures on a mappable scale. These two universal and timeless abilities are necessary to people who deal with geological maps, cross-sections or 3D models in all periods of geoscience development, no matter which tools are used for their construction due to the specific stage of technological progress. Understanding and reading maps remain one of the most basic competences required from every geology student and, later, every professional.

The present tome is by all means introductory, as its title evidently suggests. Still, it is geared not solely to undergraduates, mostly first-year students of geology at universities and colleges or even secondary school students who have geology classes. Readers of this volume are also those for whom geology is a subsidiary subject, for example during studying civil engineering, environmental engineering or geography. All topics are introduced from the very beginning, and they are thoroughly, yet clearly and straightforwardly explained. The authors seemingly paid due attention to introduce, in a precise and easy manner, numerous basic and fundamental terms and concepts, which are connected with the interpretation of geological structures in maps and cross-sections. This makes this volume useful for self study, and not suitable only for learning under the supervision of a teacher. The sequence of components of this textbook, namely an order of the main groups of geological structures presented is optimal for harmonious deepening of knowledge. The first chapters discuss easily understandable, uniformly oriented bedding (horizontal and dipping strata). Afterwards, the authors introduce more geometrically and genetically complicated structures – unconformities, folds and faults. The final parts of the book describe igneous bodies and features formed by impacts of cosmic objects, as well as other complex structures, for example tectonic nappes. The book includes also a separate chapter entitled, 'Economic problems', which is composed of several tasks devoted to the use of geological cartography in applied geoscienc-

es, mining and civil engineering. The problems included in this unit refer to the prospecting and exploitation of mineral resources (magmatic ore deposits, sedimentary ironstones) and development of hydrotechnical constructions. What seems to be a sign of the time, reflecting the rather old roots of the present book, is that the chapter includes two maps connected with coal seams. This energetic resource, with a very long history of exploitation in Great Britain, is not mined there anymore. However, in Poland coal is still being extracted (both hard coal and lignite), which makes the problems related with this combustible rock still topical. The 'Economic problems' indirectly introduces issues of subsurface geological mapping. Surprisingly, this is the chapter with the shortest textual part, which I find a minor shortcoming. In my opinion this might be corrected in possible future editions of the textbook by adding a text part forming an educative comment to the practical tasks.

Just as in any other textbook focused on geological maps, the deciding factor defining its value are the graphical problems to be solved by a reader. After a practical examination of vast majority of the assignments included in the present volume, I consider this to be just excellent. The book contains the rich collection of 45 numbered maps related to different geological features. Each of these represents a single, independent problem to solve. All of the maps are made in black-and-white, with patterns (shadings) reflecting specific rock types, as well as with text annotations, where needed, and attitude (orientation) symbols present in part of the maps. The graphical patterns used in this textbook are compiled in a special Key, to be found just after the preface. The maps are precisely and correctly drawn, which strongly helps the reader in making the necessary geometric constructions, such as drawing structure contours, making three-point problem interpolations or establishing angles of dip necessary for construction of cross-sections. Thanks to the accuracy and correctness of these maps, the solutions obtained by a student are unambiguous, i.e. they do not leave him/her with unnecessary doubts as to the correctness of results obtained. Here I need to admit, that one of the book components I find somewhat controversial and perhaps not necessary. The volume includes in the Appendix completed solutions to graphic tasks, as well as other answers related to map interpretations. Obviously, this is helpful in case of self study, but it may demotivate students during their work by creating the possibility of easy checking the expected results. Having a long experience in teaching geological mapping, I do need to stress here that the maps

included in this book also present good opportunities to create new tasks, to modify assignments proposed by the authors or to draw cross-sections along alternative lines on maps.

All assignments originally intended by the authors to include a cross-section along an indicated line, are supplemented with a sketch of a dedicated topographic profile. These morphological frames save time and enable students to concentrate just on constructions referring to the geological context (while not forgetting about the interrelationships between the Earth's surface morphology and its geological background). The majority of maps in this book are based on analysis including structure contour construction, so the solutions are obtained based on the relations between geological boundaries and topographic contours. However, two separate sections (chapters 7 and 9) focus on maps that are devoid of topographic contours, and in which the orientation of strata is indicated by graphical symbols. These two groups of problems are closer to reading and interpretation of the published geological maps. The majority of the maps included represent simple, theoretical examples created by the authors to show representative geometries and typical map patterns for the given types of geological structures (e.g. dipping strata, angular conformity, horizontal folds, etc.). However, some of these (e.g. Maps 3, 19 and 35) are based on authentic areas. I treat this as an appropriate step for building up the credibility of this book in the eyes of the reader, by showing a reference to geological reality.

Apart from the maps included, with tasks described both in the captions, next to these or in special boxes entitled 'Notes on Map' or 'Questions on Map', the authors offer also a set of so-called exercises, which are based on work with fourteen maps published by the British Geological Survey, mostly having 1:50,000 scale. This component strongly enriches the textbook, by redirecting students to genuine, field-based geological cartographic materials, which are usually much more complex than the basic-level exercise maps showing small areas, usually covering several square kilometres up to a few tens of square kilometres. The geological survey maps in this book for analysis are accessible through an open-access online map viewer of the BGS. This makes it fairly easy to apply at least part of the tasks mentioned in the volume with reference to the British Geological Survey sheets. Yet, these BGS maps can also be replaced by non-British teachers and students by maps published for their native territories by national geological surveys. Definitely, the work on geological maps showing genuine areas seems to be indispensable for shap-

ing complete knowledge on interpretation of geological maps, also at the introductory level.

The book reviewed offers just one example of a published geological map (page 39), which contains a fragment of the 1:50,000 BGS map, sheet Brighton and Worthing. The map includes a model pattern of two adjacent folds and is addressed in a dedicated complex task, called Problem 1. The book includes three such distinguished assignments, named the Problems. Problem 2 refers to the correlation of four borehole logs, while Problem 3 is related to the interpretation of a section exposed (quarry face). These problem tasks widen the scope of the book by presenting different attitudes to data referring to geological structures, and perhaps their number in the book should even have been higher. I found it hard to resist making a bitter comment about the slightly too complicated scheme of tasks proposed in the book. Readers will find here Maps with captions, Notes and Questions addressed to these, Exercises referring to the geological survey maps, and, additionally, separate Problems. Perhaps, this could have been simplified.

Above, I have focused on the cartographic components of this book, i.e. the maps. However, an equally important part is the written text. In it, the authors explain individual groups of geological structures, and refer to issues related to making and reading geological maps within different contexts, including the currently strongly developing planetary sciences. The authors frequently address regional examples, both from Great Britain and abroad. The text is illustrated by numerous black-and-white drawings. Every chapter comprises several, occasionally more than ten such figures, which are separately numbered in each unit. These sketches are usually schematic, sometimes simplified, but thanks to this simplicity the figures correctly play their educative role. They properly explain the fundamentals of geometric constructions applied for map interpretation (e.g. Figures 3.3 and 3.4 explaining the idea of structure contours and their relation to dip angle), the anatomy and origin of specific geological structures (e.g. Fig. 6.13, explaining the formation of cross-bedding), or parameters of tectonic features (e.g. Fig. 8.4, showing fault parameters). Usually, the figures are clearly commented on in the text body.

The text is also supplemented by a large number of comparatively small, yet very high-quality photographs referred to as Plates, in contrast to the drawings (Figures). The thirty-one photographs show numerous examples of geological structures documented in the field, mainly in the United Kingdom, but also in other famous localities, such as Mt. Etna, Tenerife or Meteor Crater. They efficiently illustrate a wide range of features discussed in the book. Definitely, these images can substantially help students to understand the issues introduced in the text and to envisage structures included in the problems to be solved. The photographs also add to the attractiveness of the book in the visual era, in which we are living now. All Plates are listed at one of the opening pages of the textbook, while the last pages comprise an Appendix, which includes the problem solutions (as mentioned above), but also three useful tables with recalculations of apparent dip, true thickness and outcrop width in relation to the true angle of dip. The last component of the Appendix is a set of templates for eleven cut-and-fold box models of geological structures, which, when made, can be efficient tools in developing an understanding of geological structure geometry and increasing students' imagination. Finally, an important supplementary element of the book is a short, three-page Glossary, preceding an Index of terms. It includes a large set of definitions explaining numerous terms (about 80 items), which appear throughout the main text. The proposed definitions are short and simple, which makes them easily accessible to geological beginners.

The first author of the present tome, Dr George M. Bennison sadly passed away in 2022. Still, I remain hopeful that there will be a ninth edition of this excellent textbook (perhaps extended by a chapter related to novel computer-based techniques?). In my opinion, the volume reviewed should still be treated as one of the best manuals to geological map interpretation by efficiently and passionately introducing the intriguing and beautiful world of geological structures and their visualisation in maps and cross-sections.

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